The Analysis of Verbal Behavior 2012, **28,** 101–110

The Effects of Tact Training on Stereotypic Vocalizations in Children With Autism

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This study was a systematic extension of Karmali, Greer, Nuzzulo-Gomez, Ross, and Rivera-Valdes (2005) and Ahearn, Clark, MacDonald, and Chung (2007). We investigated the effects of a tact correction procedure on stereotypic vocalizations in 4 children diagnosed with autism who ranged in age from 6 to 16 years. Participants had limited vocal verbal repertoires and were primarily dependent on prompts for the emission of appropriate vocalizations. A multiple-baseline design across participants was used. Data were collected on instances of stereotypic vocalizations and independent tacts during baseline conditions and on instances of stereotypic vocalizations, independent tacts, and echoic-tacts during intervention. Procedural integrity and social validity data were also obtained. The results indicated a decrease in stereotypic vocalizations for 3 of the 4 participants and a slight increase in appropriate vocal verbal behavior (i.e., tacting) for all participants. The study provides support for the use of tact correction procedures to decrease stereotypic vocalizations and increase appropriate vocalizations in children with autism.

Key words: autism, echoics, stereotypic vocalizations, tacts, tact correction, verbal behavior

The acquisition of verbal behavior marks a critical developmental milestone for children. Children diagnosed with autism often display deficits in verbal behavior, leading caregivers to seek professional assistance to increase functional communication. Moreover, children diagnosed with autism often demonstrate repetitive behaviors and may commonly repeat or echo language they hear (Wing & Gould, 1979). These behaviors can become problematic by interfering with the development of intraverbal behavior (Foxx, Faw, McMorrow, Kyle, & Bittle, 1988), and delaying the development of academic and social behaviors (Schreibman & Carr, 1978). They can also become socially stigmatizing (Cunningham & Schreibman, 2008). Learning is inhibited because the individual is repeating phrases, statements, or responses and is, therefore, not attending to the events that are occurring in the current environment. Moreover, the student may miss key concepts being taught. When an individual engages in these behaviors at a high rate, the probability of actively engaging in learning opportunities within the classroom may decline.

Two interventions that have been examined to reduce stereotypic vocalizations include tact correction procedures (Karmali, Greer, Nuzzulo-Gomez, Ross, & Rivera-Valdes, 2005; Pistoljevic & Greer, 2006) and response interruption and redirection (RIRD; Ahearn et al., 2007; Liu-Gitz & Banda, 2010; Miguel, Clark, Tereshko, & Ahearn, 2009). Karmali et al. (2005) studied the effects of a tact correction on palilalia (defined as the delayed form of echolalia or stereotypic vocalizations) in 5 preschoolers with autism. During the tact correction procedure, the experimenter immediately tacted an object in the environment or an activity the participant was engaged in (e.g., ''I'm coloring,'' ''This is the color purple'') when a participant emitted palilalic behavior (e.g., ''I will huff and puff and blow your house down''). If the participant continued to engage in palilalia, experimenters prompted a tact of another item or activity in the participant's immediate environment (e.g., ''I am still coloring''). If the palilalia ceased after the second tact, the prompting stopped.

Traci Cihon is now at The University of North Texas. This study is based on the first author's thesis completed under the supervision of the second and third authors in partial fulfillment of the master of science degree at The Chicago School of Professional Psychology. The study was presented at the 2009 ABAI conference in Phoenix, AZ.

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If the participant repeated the tact (i.e., echoic-tact) and stopped emitting palilalia, experimenters delivered verbal praise. Results indicated that palilalia decreased to low and stable levels and the rate of mands and tacts increased following tact correction. Reversals to baseline provided additional evidence for the functional relation between the tact corrections and rate of palilalia, mands, and tacts.

Ahearn et al. (2007) examined the effects of RIRD on stereotypic vocalizations in 4 children with autism. During RIRD, experimenters provided prompts for appropriate language contingent upon stereotypic vocalizations. Prompts continued until participants emitted three consecutive correct vocalizations. Appropriate vocalizations were followed with either social praise or the item/activity the participant requested. The results showed a decrease in stereotypic vocalizations for all participants and an increase in appropriate vocalizations for 3 of the 4 participants.

The primary difference between tact correction procedures and RIRD is the type of appropriate response the individual is asked to engage in following the stereotypic vocalization. In tact correction procedures, the experimenter emits a contextually appropriate tact that the participant is expected to echo, whereas in RIRD procedures, the experimenter asks the participant to engage in a previously acquired vocalization of any form (e.g., answering questions, vocal imitation, etc.). For either procedure, it is unclear whether the intervention serves as a positive punisher, reducing stereotypic vocalizations, or whether the reinforcement delivered contingent upon appropriate vocalizations competes with the consequences that were previously maintaining the stereotypic vocalizations.

Few studies have explored tact correction (Karmali et al., 2005) and RIRD (Ahearn et al., 2007; Liu-Gitz & Banda, 2010; Miguel et al., 2009) and its effects on stereotypic vocalizations and appropriate vocal repertoires. The current study was a systematic extension of Karmali et al. (2005) and Ahearn et al. (2007). Dependent variables were defined similarly to Ahearn et al. and the independent variable was based on Karmali et al. Specifically, the tact correction procedure from Karmali et al. was contingent upon stereotypic vocalizations (consistent with Ahearn et al.) and the number of echoic-tacts that participants emitted during the tact correction procedure was recorded. The specific research questions addressed were: (a) does implementing the tact correction procedure decrease stereotypic vocalizations? and, (b) will participants develop appropriate vocal verbal behaviors evidenced by an increase in independently emitted tacts?

METHODS

Participants

Four children between the ages of 6 and 16 years with a diagnosis of autism participated in the study. GH was 6, PM 11, JL 13, and RS 16 years old. All participants were males who emitted stereotypic vocalizations at a rate that was disruptive to their daily activities and social interactions (including academic programming). The participants' stereotypic vocalizations typically included words and sentences from various television shows, movies, books, and toys. Moreover, each participant demonstrated some appropriate vocal verbal behavior, but this behavior was usually emitted only when prompted. A functional analysis was not conducted for stereotypic vocalizations, but each of the participants' teachers indicated that the stereotypic vocalizations were likely maintained by automatic reinforcement (it is often suggested that stereotypic vocalizations are maintained by automatic reinforcement; Cunningham & Schreibman, 2008).

Setting

The participants were students who attended a private rehabilitative school for individuals with autism that was part of a not-for-profit community-based agency that served approximately 400 children and adults with mild to severe disabilities. The school had four classrooms, servicing students from the ages of 4 to 21 years old. GH, PM, and JL's classrooms were comprised of five students, one special education teacher, and five personal paraprofessionals (i.e., aides) who worked one-on-one with their assigned

Table 1
Examples and Nonexamples of Participant's Episodes of Stereotypic Vocalizations

Participant	Counted	Not counted
GH	Nonsensical utterances if a beginning and end were clearly heard (e.g., bah, ah, uh)	Long hums or singing
RS	Scripted (repeated) mands or tacts to himself and others, utterances that had a clear beginning and end (i.e., not drawn out)	Singing or loud vocalization, ''umph''
PM	Nonsensical utterances and sound effects (if clear) with a beginning and end (e.g., crashing sound)	Singing or humming
JL	Phrases directly stated from TV or movies, questions repeatedly asked of staff	Novel questions asked to various staff members

student. RS's classroom had the same student to staff ratio, but there were six students.

Sessions were conducted in various locations within the school. Some of the participants' sessions took place in their designated classrooms. Each classroom contained a desk area composed of cubicles that sectioned off each student's work area and contained small plastic containers holding programming materials, supplies, reinforcers, and other items required for instruction. Sessions were also conducted in the gymnasium; a small room lined with floor mats that contained a variety of swings, tubes, and balls with which the students played. PM and JL's sessions were also conducted in the lunch room, which contained two small rectangular tables and 13 chairs that were stacked in the corner unless they were in use. Finally, some of RS's sessions were conducted during a designated chore in which he was responsible for walking into different classrooms to collect and dispose of the recyclable materials in the recycling bin located outside the school.

Response Measurement and Interobserver Agreement

The dependent variables in the study were vocal verbal responses classified as stereotypic vocalizations, independent tacts, and echoic-tacts. Stereotypic vocalizations were defined as delayed, noncontextual repetitive speech or the occurrence of a vocal verbal utterance with point-to-point correspondence to an auditory stimulus that had no direct relation to any object, event, or vocal stimulus in the immediate environment.

The topographies of stereotypic vocalizations differed across participants; therefore, individual response definitions were used. Examples and nonexamples of participants' stereotypic vocalizations are presented in Table 1. All participants' stereotypic vocalizations included instances of noncontextual vocal verbal utterances that consisted either of individual words or sentences; clearly stated, blended together, or combined in a nonsensical manner.

Independent tact responses were defined as vocal responses emitted in the presence of a nonverbal stimulus to which the tact was appropriate (Skinner, 1957). Tacts did not require an autoclitic frame to be counted as correct. Echoic-tact responses were defined as vocal verbal responses that had point-to-point correspondence and formal similarity to the vocal verbal prompt presented by the experimenter in the presence of a nonverbal stimulus (Bondy, Tincani, & Frost, 2004). For an echoic-tact to be scored as correct, the participant had to repeat the entire vocal utterance (including the autoclitic frame) the experimenter presented (e.g., ''I'm playing Candyland,'' ''I landed on red,'' ''I am sweeping'').

Data were collected on instances of stereotypic vocalizations and independent tacts per 10-min session for each participant during baseline and during the intervention. During intervention, experimenters also collected data on instances of echoic-tacts. Three observers, trained during mock experimental sessions, detected the occurrences of the dependent variables at 90% accuracy. Interobserver agreement (IOA) was scored for 27% of baseline sessions and 31% of intervention sessions across all participants. IOA was calculated by dividing the smaller number of instances by the larger number of instances of the dependent variables per 10 min interval and

multiplying by 100. The mean IOA across participants for baseline sessions was 95% (range, 64% to 100%). The mean IOA for intervention sessions was 92% (range, 79% to 100%). The mean IOA during baseline was 77% (range, 64% to 84%) for GH, 85% (range, 69% to 94%) for PM, 88% (range, 69% to 94%) for RS, and 88% (range, 75% to 100%) for JL. The mean IOA during intervention was 94% (range, 79% to 100%) for GH, 87% (range, 84% to 100%) for PM, 91% (range, 83% to 98%) for RS, and 92% (range, 91% to 93%) for JL. Instances of stereotypic vocalizations occurred often during observation sessions, and at times it was difficult to discriminate between words because they were either inaudible or nonsensical. This yielded the low end of the range of IOA; however, agreement improved after introducing examples and nonexamples of stereotypic vocalizations specific to each participant (see Table 1).

Treatment Integrity

Treatment integrity was assessed for 27% of baseline sessions and 31% of intervention sessions. Observers read the procedures individually and were then trained to a criterion of 90% agreement on mock experimental sessions prior to the onset of the experiment. Data were collected on the experimenter's presentation of the tact correction procedure, the delivery of contingent praise, and the onset of the verbal antecedent. Treatment integrity was calculated by dividing the number of steps correctly implemented by the total number of steps and multiplying by 100. Treatment integrity for baseline and intervention sessions was 100%.

Experimental Design

A multiple-baseline design across participants (Baer, Wolf, & Risley, 1968) was used to assess the effects of the tact correction procedure on stereotypic vocalizations, independent tacts, and echoic-tacts.

Procedure

Baseline. Sessions were conducted across a variety of activities including free-time, snack, gym, lunch, group activity, and rarely one-on-one instruction. Upon the first emission of stereotypic vocalizations, the experimenter started the stopwatch and, if present, the participant's aide would continue engaging the participant in the activity. If stereotypic vocalizations were not emitted within the first 2 min of the session, the experimenter started the stopwatch. The experimenter then began recording instances of the dependent variables. Stereotypic vocalizations were ignored. Praise was delivered contingent upon independent tacts.

Intervention. Sessions began according to the same criterion used in baseline. Tact correction was implemented upon the first instance of stereotypic vocalizations. The experimenter made a vocal verbal statement under the control of a nonverbal stimulus (i.e., tact) in response to a participant's stereotypic vocalizations. For example, if the participant emitted stereotypic vocalizations when playing the game *Candyland*, the experimenter would give a verbal antecedent, such as, ''I am playing Candyland,'' and would wait 3 s to see if the child repeated the statement. If the repeated statement had point-to-point correspondence and formal similarity with the experimenter's provided tact (vocal verbal stimulus), the response was followed with social praise, assumed to function as a generalized conditioned reinforcer (e.g., ''That's right, you are playing Candyland''). Social praise was delivered on a continuous schedule of reinforcement (FR1).

If the participant did not echo the appropriate tact (e.g., ''I am playing Candyland''), but stopped emitting stereotypic vocalizations, the experimenter did not deliver social praise. If the participant continued to engage in stereotypic vocalizations, the experimenter would provide a second tact correction by presenting a vocal verbal stimulus that corresponded to another current environmental condition (e.g., ''I am using the red game piece''). Social praise was delivered contingent upon any independent or echoic-tacts emitted during the session.

RESULTS

Instances of stereotypic vocalizations across baseline and intervention sessions for all participants are depicted in Figure 1. The

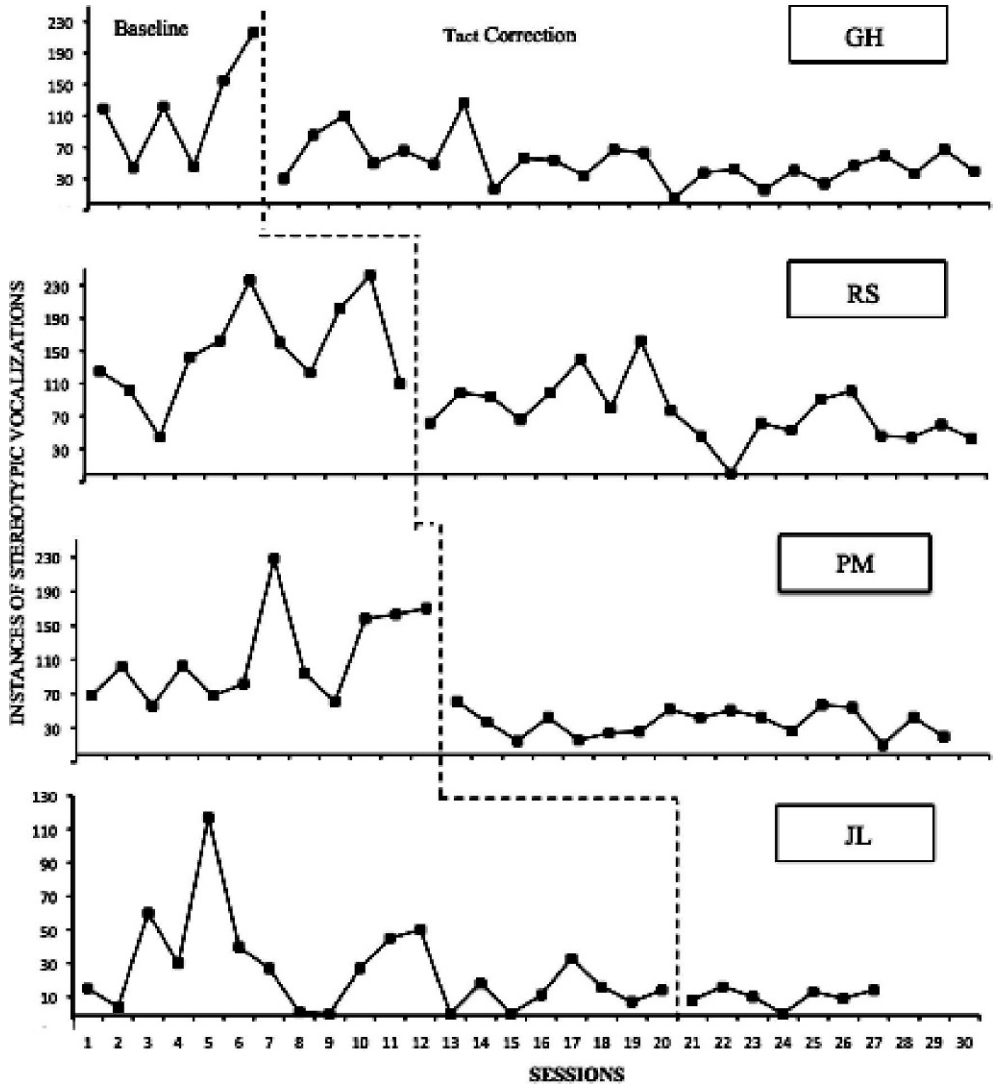

Figure 1. Instances of stereotypic vocalizations per 10 min baseline and intervention session for all participants.

mean counts of each dependent variable for baseline and intervention sessions are presented in Table 2. In general, stereotypic vocalizations decreased following the tact correction procedure for all participants except JL, whose responding was initially high but decreased throughout baseline and remained low during intervention.

GH's baseline stereotypic vocalizations (top panel, Figure 1) were variable; however, during the last three sessions the data showed an ascending trend. Upon implementation of the tact correction procedure, stereotypic vocalizations decreased but remained variable. RS's stereotypic vocalizations (second panel, Figure 1) showed a variable and increasing trend in baseline. Upon implementation of the tact correction procedure, stereotypic vocalizations decreased but remained variable. PM's baseline stereotypic vocalizations (third panel, Figure 1) were initially variable and increased in the four sessions prior to intervention. Stereotypic vocalizations decreased following tact correction. JL's baseline stereotypic vocalizations (bottom panel, Figure 1) were initially high and then lessened prior to intervention during baseline. JL

did not demonstrate a decrease in stereotypic vocalizations during the intervention.

Instances of independent tacts and echoic-tacts across participants are depicted in Figure 2. All participants showed at least some gain in independent tact and echoic-tact repertoires. GH's independent tacts (top panel, Figure 2) were low and stable during baseline. Upon implementation of the tact correction procedure, GH showed a slight increase in independent tacts and emitted echoic-tacts at about the same level. RS's baseline independent tacts (second panel, Figure 2) were low and stable. Upon intervention, responding remained low and stable until the 24th session, when responding increased and remained at a level above that demonstrated in baseline. Initially, RS emitted echoic-tacts more often than independent tacts, but this trend reversed after six sessions of intervention. PM's independent tacts (third panel, Figure 2) were low and stable during baseline. Data were variable upon implementation of the tact correction procedure but showed an overall increase in independent tacts. At the onset of intervention, PM initially emitted more echoic-tacts than independent tacts. During the last few sessions, PM was emitting more independent tacts than echoic-tacts. JL emitted few independent tacts during baseline (bottom panel, Figure 2). Independent tacts increased following tact correction, and echoic-tacts remained low and stable.

A questionnaire was administered to the classroom teacher and aide for each participant (8 total respondents). Questions were open-ended and focused on the effectiveness of the treatment (i.e., was there a noticeable decrease in stereotypic vocalizations) and whether the participants began to emit appropriate vocal verbal behavior outside of experimental sessions (i.e., whether there was a noticeable increase in tacts and echoic-tacts). The results of the social validity questionnaire suggest all teachers and aides observed some improvement in at least one component of the participants' vocal verbal repertoire (e.g., either a decrease in stereotypic vocalizations or an increase in more functional vocal verbal behavior).

DISCUSSION

The data indicate that a decrease in stereotypic vocalizations as observed for 3 of the 4 participants upon the implementation of the tact correction procedure. These results provide further evidence supporting the effectiveness of tact correction procedures to decrease stereotypic vocalizations in children with autism (Karmali et al., 2005). Furthermore, all participants showed at least some increase in the level of independent tacts emitted. These findings extend previous research showing gains in appropriate vocalizations using tact correction procedures (Karmali et al., 2005) and RIRD (Ahearn et al., 2007; Liu-Gitz & Banda, 2010; Miguel et al., 2009).

There were several limitations to the present research. First, stereotypic vocalizations vary in intensity, topography, and function within and across individuals. As a result, determining the best way to measure stereotypic vocalizations proved difficult. In the current study, instances of stereotypic vocalizations were measured using a mechanical counter; however, many of the participants spoke quickly and blended words together or mumbled. The observers had difficulties getting an exact count, and some instances of stereotypic vocalizations were probably under- or overestimated. This difficulty may be reflected in the broad range of IOA scores reported. Although the mean agreement was in the acceptable range, the low end supports the challenges associated with accurately recording instances of stereotypic vocalizations. Future researchers may wish to consider alternative recording methods (e.g., interval recording) to make the procedure easier for school personnel to implement. The second limitation was the effort associated with measuring the dependent variables while accurately implementing the tact correction procedure. The tact correction procedure may result in low procedural integrity due to the many responses teachers would be required to emit. Unfortunately, the social validity questionnaire did not include questions regarding the ease of implementation or the likelihood to continue the intervention in the absence of the experimenter. Future research could directly assess these variables and examine variations of the procedure that may minimize the intensity of the implementation but still produce participant gains. For example, teachers may record only instances of

Table 2
Mean Instances of Stereotypic Vocalizations, Independent Tacts, and Echoic-tacts for All Participants Across Baseline and Intervention Sessions

Participant	Variable	Baseline	Intervention
GH	Stereotypic vocalizations	117 (range, 44 to 216)	51.1 (range, 6 to 126)
	Independent tacts	0.66 (range, 0 to 2)	2.16 (range, 0 to 8)
	Echoic-tacts	N/A	1.96 (range, 0 to 11)
RS	Stereotypic vocalizations	149.9 (range, 45 to 242)	75 (range, 0 to 162)
	Independent tacts	0.36 (range, 0 to 1)	1.63 (range, 0 to 6)
	Echoic-tacts	N/A	1.26 (range, 0 to 5)
PM	Stereotypic vocalizations	113.8 (range, 56 to 228)	36.5 (range, 10 to 61)
	Independent tacts	1.17 (range, 0 to 2)	4.24 (range, 0 to 28)
	Echoic-tacts	N/A	6.59 (range, 4 to 13)
JL	Stereotypic vocalizations	25.8 (range, 0 to 117)	10 (range, 0 to 16)
	Independent tacts	2 (range, 0 to 7)	15.1 (range, 6 to 35)
	Echoic-tacts	N/A	0.71 (range, 0 to 2)

stereotypic vocalizations and independent tacts; sessions could be videotaped and data recorded later.

Fourth, experimenters did not conduct a functional analysis at the onset of the study to determine variables maintaining stereotypic vocalizations. The effectiveness of the intervention bolsters the accuracy of teacher reports that the stereotypic vocalizations were, in fact, maintained by automatic reinforcement and not socially mediated consequences. For example, if stereotypic vocalizations were maintained by positive reinforcement in the form of attention, stereotypic vocalizations would likely have increased following the tact correction procedures. Even so, clinicians should be sure to assess the function of the stereotypic vocalizations as this intervention would not be recommended if the vocalizations were socially mediated (cf., Kennedy, Meyer, Knowles, & Shukla, 2000; Mace, Browder, & Lin, 1987). Finally, there were mistakes in implementation. Experimenters intervened on a descending baseline trend for RS; and to better stagger the multiple baseline, PM's baseline sessions could have run longer before starting the tact correction procedure.

Despite these limitations, the overall level of stereotypic vocalizations decreased for RS, and the results obtained for GH and PM ensure sufficient replication, verification, and prediction to demonstrate a functional relation between the independent and dependent variables. JL did not demonstrate as noteworthy of a decrease in stereotypic vocalizations as the other participants. In fact, data from the last three sessions of baseline were similar to data from tact correction. It could be argued that a functional relation was not demonstrated for this participant; however, given that JL emitted low levels of stereotypic vocalizations prior to the onset of intervention, it is more likely that there is a limit to the suppressive effects of this intervention. Moreover, it is possible that automatic reinforcement was responsible for the low levels of stereotypic vocalizations following intervention observed across all participants. Nevertheless, JL (and the other participants) did demonstrate a slight increase in appropriate vocalizations.

The effects of the tact correction procedure on independent tacts and echoic-tacts varied across participants with PM and JL demonstrating the largest gains in appropriate vocalizations. There are several plausible explanations for this. First, due to infrequent emissions of echoic-tacts during intervention, participants may not have contacted the reinforcement contingencies for tacting via the emission of echoic-tacts. Second, the relative rates of reinforcement for echoic-tacts and independent tacts did not vary in such a way that encouraged the emission of independent tacts over echoic-tacts (cf., Karsten & Carr, 2009). Third, praise may not have functioned as a generalized conditioned reinforcer for all participants. Possibly, by using tangible items or activities in

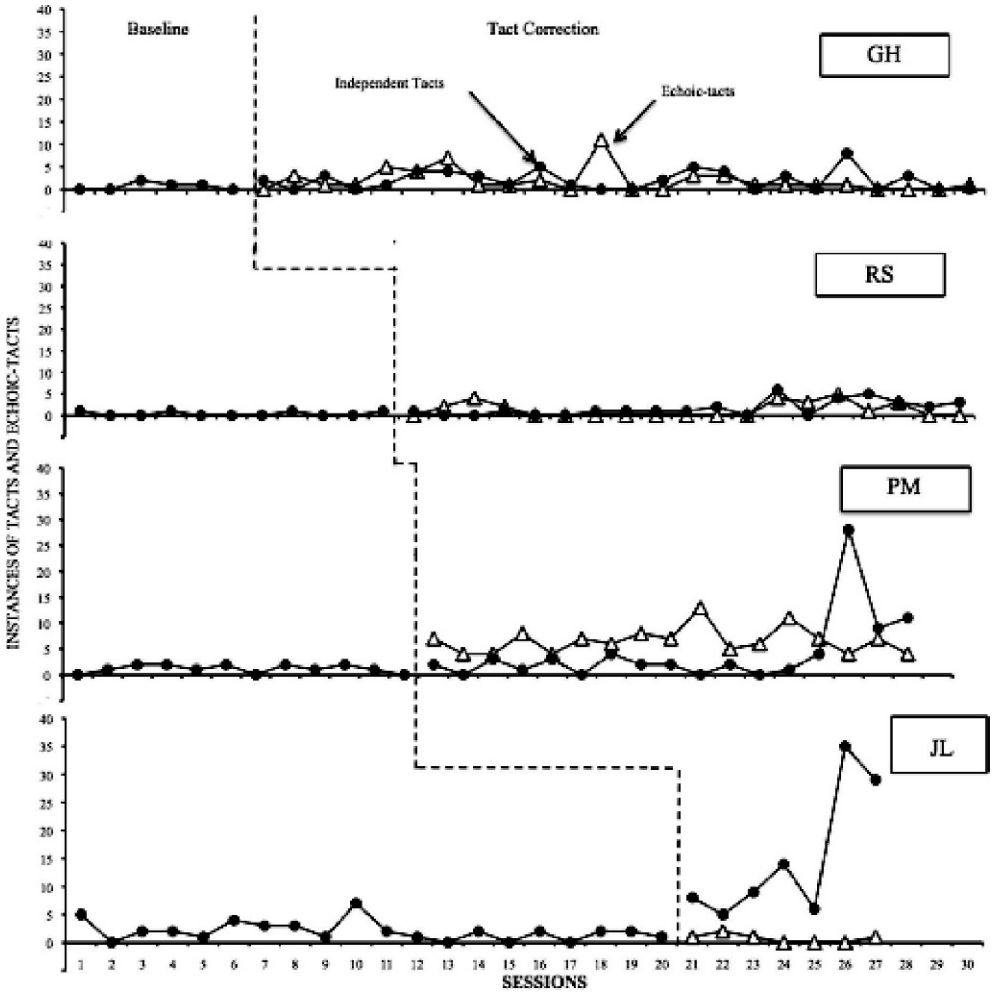

Figure 2. Instances of independent tacts and echoic-tacts per 10 min baseline and intervention session for all participants.

place of social praise, a more substantial increase in appropriate vocalizations would have been observed. However, Karmali et al. (2005) speculated that stereotypic vocalizations often occurred due to a ''paucity of reinforcement.'' Future researchers might condition more stimuli as reinforcers before implementing a tact correction procedure or yoke the schedules of reinforcement across conditions.

The mechanisms responsible for the decrease in stereotypic vocalizations and increase in appropriate vocalizations are unclear. It is possible that tact correction procedures and RIRD function as positive punishment or extinction. The literature regarding response blocking procedures has been inconclusive. Lerman and Iwata (1996) found that response blocking suppressed responding through punishment contingencies. However, Smith, Russo, and Le (1999) replicated this study and found that response blocking suppressed responding via extinction. It is possible, then, that response blocking may function as a punisher for some individuals, and as extinction for others. Because our study did not attempt to address this, it is unclear if either of these mechanisms were responsible for the changes in behavior.

In addition, some might ask why the tact correction procedure or RIRD might function to increase appropriate vocalizations. It is possible that the appropriate vocalizations

might serve as competing responses to stereotypic vocalizations or that the social praise contingent upon the appropriate vocalizations somehow competes with the automatic reinforcers that often maintain stereotypic vocalizations. Another possibility is that appropriate vocalizations serve as incompatible responses to stereotypic vocalizations; and once participants contact reinforcers for appropriate responding, increases and decreases in target behaviors may result. Research that attempts to answer questions related to the behavioral mechanisms responsible for the effectiveness of these procedures should be conducted. Answering this question might also assist researchers and practitioners in developing procedural variations that result in larger gains in appropriate vocalizations than observed in previous research (Ahearn, et al., 2007; Karmali et al., 2005; Liu-Gitz & Banda, 2010; Miguel, et al., 2009).

Overall, the current study replicated and extended the results obtained in previous studies attempting to reduce stereotypic vocalizations while simultaneously increasing appropriate vocalizations (Ahearn et al., 2007; Karmali et al., 2005; Liu-Gitz & Banda, 2010; Miguel et al., 2009). All participants displayed more appropriate vocal verbal behavior in the form of independent tacts and echoic tacts and 3 of the 4 participants demonstrated decreases in stereotypic vocalizations.

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